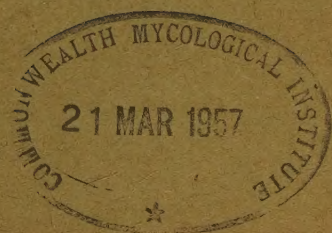


ANNUAL REPORT
of the
WEST AFRICAN
RICE RESEARCH
STATION

1954



ADMINISTERING AUTHORITY

THE SIERRA LEONE GOVERNMENT

(*Director of Agriculture*: G. W. LINES, M.B.E., M.A. DIP. AGRIC. SCI.)

SENIOR STAFF

At 31st December, 1954

Principal Agricultural Officer:

P. ADAMES, M.A., A.I.C.T.A.

Agricultural Officer:

H. D. JORDAN, B.SC., A.R.C.S., A.I.C.T.A.

Botanist:

W. JACKSON, B.SC.

Chemist:

T. E. TOMLINSON, B.A., D.PHIL., A.R.I.C.

Laboratory Superintendent:

R. D. J. MACAULEY



WEST AFRICAN RICE RESEARCH STATION
Laboratory Wing of Main Building

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Price 1/-

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INTRODUCTION

An agricultural station was opened in 1934 at Rokupr by the Sierra Leone Department of Agriculture. This station was established for the purpose of experimental work on rice growing in tidal mangrove areas and as a source of pure seed of improved rice varieties for distribution to local farmers. Despite staff limitations much valuable work was carried out, mainly in the direction of improving cultural practices and of popularizing improved varieties, obtained both by introduction and by selection from local rices. At the end of 1947 suggestions were made for the expansion of this station in view of increased interest being taken in rice by the four British West African territories. A scheme was prepared whereby the capital costs would be met by a grant under the Colonial Development and Welfare Act, which would also provide a half of the running cost—the other half being met by contributions from the four territories concerned. In view of the small size of the station it was not proposed to make it entirely independent, but that it should continue to be administered by the Sierra Leone Government through its Director of Agriculture and his Principal Agricultural Officer, who would be resident on the station, and that the staff would be subject to the regulations of the Sierra Leone Government. This scheme was approved by the Secretary of State in 1949 and a start was made on construction in 1950. Owing to difficulty in obtaining materials however little progress was made until 1953. Staff has been difficult to recruit also, one botanist arriving in late 1952 and one chemist in early 1953.

1954 has seen a substantial improvement from the constructional and organization standpoint, though the staff position continues to be unsatisfactory. It has not been possible therefore to embark on any ambitious programme and work has been confined in general to consolidation and expansion of existing lines of research on the botanical side, together with preparations for a full chemical programme to be started when the Chemist returns from leave in 1955.

STAFF

The Principal Agricultural Officer Scarcies has continued to be the officer in charge of the station. Mr. P. Adames, the holder of this post, was at Rokupr until April when Mr. H. D. Jordan returned from leave. Mr. Adames was then transferred to Departmental Head Quarters, and Mr. Jordan acted in the position for the remainder of the year, except for a short period in August when Mr. Adames returned to Rokupr, prior to going on leave.

No further appointments were made to the Research staff, which continued as one botanist and one chemist. Mr. W. Jackson, the Botanist, was away on leave from April to September. Dr. T. E. Tomlinson, Chemist, visited the Belgian Congo to attend the 5th International Congress of Soil Science at Leopoldville in August and early September. He proceeded on leave in mid-October.

Mr. R. D. J. Macauley, a retired government officer, was appointed to the temporary position of Laboratory Superintendent in the Chemistry section in May.

The position with regard to junior staff is slightly more satisfactory and is summarized in the following table:—

	<i>Projected</i>	<i>Appointed</i>
Clerks	4	4
Storekeeper	1	1
Librarian	1	1
Agricultural Instructors	7	3
Laboratory Assistants	2	1
Laboratory Attendants	4	2
Artisans Etc.	25	21

A number of these are only temporary appointments, and one clerk was away under training in clerical work for a large part of the year.

CONSTRUCTION

The internal fitting of laboratories and offices was carried out in the early part of the year and the building occupied. Owing to some delay in the electric wiring it was not however possible to put the gas and vacuum services into operation and they were still not in use by the end of the year. The lack of electrical services until after the departure of the Chemist on leave seriously curtailed the work which could be done during the year. However, with the exception of the dark room for which special switches are required, wiring of the laboratory was completed by the end of the year. The main water storage tank was erected at the beginning of the year and the water supply completed. Four further junior service quarters were built, making the total of new ones ten. There is now little of the capital construction programme still to be carried out. The main item is the alteration or replacement of the remaining old house on the station.

LIBRARY AND PUBLICATIONS

Further books, and also an increased supply of pamphlets and reprints, have been obtained. Periodicals have been received regularly and the punched card abstracting system continued. The following paper was published:—

H. D. Jordan. The Development of Rice Research in Sierra Leone. *Tropical Agriculture*. **31**, 1, 27 (1954).

TRANSPORT

The position has remained somewhat unsatisfactory. The 3 ton Bedford lorry on order has not yet been received and the 30 cwt. Commer van has been very unreliable. The departmental launch was under repair for a large part of the year, the T20 runabout launch being the only river transport available.

STATION LAYOUT

The area around the office and laboratories was laid out with lawns. No increase in the area of swamp under cultivation was made and the parts not required for experimental purposes were used as hitherto for the multiplication of pure seed.

WEATHER

Full meteorological records are given in Appendix A. The year 1954 had heavier rainfall than average, this being particularly marked in the earlier part of the rainy season. July rainfall was well above average

but October was much drier than usual, and this appears to have reduced the yield of rice on the higher part of the farm.

MISCELLANEOUS WORK

A vegetable garden and nursery have been continued as has also the maintenance of fruit trees and other perennial crops.

The herd of Ndama cattle remains on the station, and a small flock of ducks and geese has been started. A piggery was built at the beginning of the year and a number of hogs were fattened for slaughter.

CONTACTS WITH OTHER COUNTRIES

An increased correspondence has been maintained on subjects connected with rice, and samples of rice varieties have been sent to several other countries. A list of these is given in Appendix B.

The following Overseas visitors have been to Rokupr:

Sir H. Poynton	Colonial Office.
Dr. H. Greene	Rothamsted Experimental Station.
S. J. E. Southgate	West African Inter-territorial Secretariat (Accra).
J. A. Blair	Achimota, Gold Coast.
J. E. Y. Hardcastle	Rice Research Station, Bida, Nigeria.

The last named spent two weeks familiarizing himself with work on rice and conditions under which it is grown in Sierra Leone.

AGRONOMY SECTION

No radical change was made in the standard methods adopted on past experience and briefly referred to in the last report.

Weather conditions were favourable for growth both in the nurseries and in the field, and attack by crabs was considerably reduced. Full details of yields are given in Appendix C.

The high standard of purity was maintained and yields were on the whole good though it is noticeable that the late varieties, particularly Kav. 12, gave yields well below average. This is thought to be due in part to the later date of sowing this year (though the difference between this season and last season was only one week) and the record low rainfall in October, which would affect the marginal land where most of the Kav. was grown more than the parts of the farm subject to more pronounced tidal irrigation. This is borne out by the fact that the mean yield of the five marginal blocks of Kav. was 630 lbs. compared with the yield of block 13 which was 2,130 lbs. (per acre).

Stocks of seed rice for distribution this year total 750 bushels made up of:—

D. 99	41	Bushels
B. G. 79	72½	„
Lead	40½	„
Sughandi	17½	„
Bolo 108	125	„
Ngasein 57	172	„
Toma 112	114½	„
India pa lil 46	123	„
Kav. 12	44	„

(The Sierra Leone bushel weighs 60 lbs.)

FERTILIZER INVESTIGATIONS

Surplus rice bran from the Mambolo rice mill was obtained and heavy applications given to most of the nurseries. Growth on these was excellent. Ammonium sulphate and superphosphate were applied to the remaining nurseries. Despite this, growth in several cases was not good, the rice being stunted and pale in colour. Symptoms were all those of nitrogen deficiency despite the ammonium sulphate application. Top dressings of lime were given to a number of these nurseries—a half of each being treated. Little difference in growth was observed. An additional trial was laid down with treatments of superphosphate and superphosphate plus sulphate of ammonia. Applications of lime and of sulphate of potash were superimposed on these. There was slightly better growth on the plot with nitrogen over that with none. Potash had no visible effect. Lime however had a noticeable effect, causing considerably stronger growth. It is apparent that fertility problems on the nurseries are not straightforward and need fuller investigation. When the staff position improves it is hoped to investigate these fully, using plant analysis in conjunction with fertilizer and trace element trials.

Previous experiments have indicated that while superphosphate gives an increase in rice yields on less fertile land, on the rich and fertile mangrove swamps it is likely to have little effect. A trial with different rates of application of superphosphate was therefore laid down on this fertile land. Yields were excellent throughout the experiment and no significant differences were apparent. Details are given in table 1.

TABLE 1

Layout: 5 × 5 Latin Square
Plots 21 × 21 ft. planted native fashion.
Area of plot harvested: 0.0074 acre.
Variety: B.G.79.

<i>Treatment</i>	<i>Mean Yield in lbs./acre</i>
8 cwt. superphosphate per acre	3,730
1 " " " "	3,490
No treatment	3,475
4 cwt. superphosphate per acre	3,445
2 " " " "	3,315
Coefficient of Variation	7.76

A number of small field trials were carried out on farms adjacent to high ground near the Great Scarcies river. Superphosphate was applied at the rate of 2 cwt. per acre to half acre plots which were sited on the less fertile soils. Though there was a general response to the application of superphosphate, it was not very great. The average increase was 128 lbs. per acre on 25 plots; a much greater increase had been expected on this marginal land.

CRAB INVESTIGATIONS

Crabs—mainly *Sesarma* (*Chiromantes*) *huzardi*, Desmarest 1825—were less of a problem this year. There was a noticeable decline in the number on the farm and with the stronger seedlings available little replanting was necessary.

Preliminary trials on crab control were carried out both in the laboratory and in the field. It is hoped to continue these trials in 1955 and to publish a paper on the results. A number of substances were tried as poison baits with poor results, mainly due to the substances being unattractive to the crabs. Technical B.H.C. was found to be extremely toxic to the crabs as a contact poison, a concentration of 6.5 ppm. of the gamma isomer in technical B.H.C. causing death, on prolonged contact, within 24 hours. Under field conditions spraying with concentrations of 325 ppm. gave adequate protection to young rice seedlings. Daily records of the numbers of egg-bearing female crabs are being kept, with a view to determining the main breeding season. So far no instance of a female of a species other than *Sesarma huzardi* bearing eggs has been recorded.

HERBICIDE AND ARBORICIDE INVESTIGATIONS

Trials were carried out by the Agricultural Officers at Bonthe and Newton on the effect of chemical weedkillers on *Rhizophora* and *Avicennia* mangroves, and on the salt resistant grass *Paspalum vaginatum*. The following is a summary of their work:—

A series of trials were carried out during the dry season using the n-butyl ester of 2 methyl 4 chloro phenoxyacetic acid (M.C.P.A.) and 2,4-dichloro phenoxyacetic acid (2,4.D) on *Rhizophora* and *Avicennia* Mangroves at Maswari. Basal spraying of trunks and prop roots using 2 per cent and 5 per cent solutions was done and there were practically no effects. Spraying the foliage of young plants caused some scorching and leaf fall but the total effect was not great and was not permanent. A few tests with frill girdling and pouring in the diluted arboricides produced wilting, but no permanent effect was noticed even after six months.

Various other arboricides had become available by early 1954 and a series of experiments were laid down in Bonthe District on *Rhizophora* mangrove in March and April. It was decided to use much stronger solutions for these trials to find out in the first instance which arboricides, if any, would kill mangrove; and also to apply all types by pouring the solution into vertical cuts and by painting the bark at the base of the trees just above the prop roots, as these were the most likely methods of application to be effective. Results were as follows:—

Controls: Ring barking and vertical cuts with no application of arboricides—no effect.

2,4.D: 6 lbs. and 10 lbs. acid per acre applied both by painting and through cuts resulted in complete defoliation. In August the effects were only just becoming noticeable; the full effects did not develop until November.

2,4,5.T.: (2,4,5—trichlorophenoxyacetic acid): 10 lbs. acid per acre applied both by painting and through cuts resulted in most of the trees being completely defoliated. So far, it appears slightly less effective than 2,4.D. and the application through cuts appears more effective than painting.

Ammonium Sulphamate: Applied as crystals (one level teaspoonful per 6 in. trunk diameter) in cuts. No effect.

M.C.P.A. (as n-butyl ester): 10 lbs. acid per acre applied through cuts resulted in all trees treated being defoliated.

Thus generally speaking it appears that 2,4.D., 2,4,5.T. and allied compounds may be effective, but it will be necessary to wait for a further period to confirm that the trees at present defoliated do die. The minimum strength to apply to kill will then have to be investigated with a further

series of experiments. From that the economics of killing mangroves by this method compared with direct felling can be assessed.

A series of experiments with trichloroacetic acid at rates from 10 lbs. to 100 lbs. per acre; ammonium sulphamate from 25 lbs. to 100 lbs. per acre; 2,4.D., 2,4,5.T. and M.C.P.A. at 10 lbs. acid per acre were laid down on plots of *Paspalum vaginatum* (a serious weed on cleared mangrove areas) in which young mangrove trees were growing. Application was by spray using Teepol as a wetting agent. A short while after application in the dry season the growth of the grass on all plots was retarded with some shoots dying, especially on the plots receiving the strongest solutions. Complete defoliation of all the young mangroves occurred. From examination of the plots some months afterwards it was clear that natural growth had been resumed and by November no differences could be seen between the treated plots and the surrounding untreated areas. These growth regulators are thus not effective on this weed or when sprayed on young mangroves.

BOTANY SECTION

INTRODUCTION OF RICE VARIETIES

A further 30 introductions of rice were made and a list of these is given in Appendix D. The collection of rices at present numbers 340, 125 native and 215 introduced, and these were grown for observation and maintenance in small plots. A number of recent introductions which seem to show promise were grown in larger plots at Rokupr, and were also grown under different conditions in other parts of the country for fuller observations to be made. Some of these grown by the Agricultural Officer at Bonthe gave over 3,000 lbs. per acre on test plots of about .04 acre. Those planted in the northern grasslands by the Agricultural Officer at Makeni were severely damaged by floods, and some (probably the best ones) were stolen.

SELECTION OF LOCAL RICES

New Selections

The river flood plains (Boli lands) were visited in December and single panicle selections made of the local varieties Kema and Lath. These are varieties resistant to total submergence. Several hundred panicles were obtained of each variety and after preliminary examination 149 and 105 panicles respectively were selected for further laboratory examination and selection and for planting in 1955.

First Year Selections

These comprise strains of two varieties—Mbagboli, a local floating rice from the Southern grasslands, and D.99 an early introduced rice which had become genetically impure. 45 strains of Mbagboli were planted as single rows of single plants and flowering records kept as an aid to determining purity. Tiller counts and measurements of panicle length were also made, though with difficulty, as the prostrate habit of the plants after flowering complicated the task. In future with floating rices each plant will be staked prior to flowering when such observations are needed. Some of the strains appear promising, but a number show indications of impurity by segregating for different characters and these are to be discarded. Similar records were kept of the 22 strains of D.99 but poor growth due to soil conditions made these of less value and the observations will be repeated in 1955.

Fourth Year Selections

4 reselections of G.E.B.24, introduced from Madras in 1931, remain and these were planted as single plants in rows from which observations and records were made. They were also planted in a yield trial in comparison with unselected G.E.B.24. Full details of this are given in Table 2. No significant differences in yield were shown, but the evenness in stature, grain size and time of ripening of the selections as compared with the unselected stock were very noticeable.

TABLE 2

Layout 5×5 Latin Square.

Plots $13\frac{1}{2} \times 13\frac{1}{2}$ ft. planted at measured 6 in. spacing, 1 plant per stand.

Area of plot harvested 0.003 acre.

<i>Variety</i>	<i>Mean Yield in lbs./acre</i>
G.E.B.24/37	2,305
G.E.B.24/17	2,290
G.E.B.24/31	2,225
G.E.B.24/20	2,190
G.E.B.24 unselected	2,165
Coefficient of Variation	7.85

Fifth Year Selections

These consist of 8 strains of Lead and 7 of B.G.79, both early rices originally introduced from British Guiana. These were grown in yield trials in 1953 but no significant differences were shown, largely due to lack of soil uniformity. They were again planted in yield trials, the plots of which were of different arrangement and shape to those of 1953 in order to try and minimise soil differences. No significant differences in yield were again shown in either trial. Full details are given in Tables 3 and 4.

The B.G. 79 strains were also planted as single plants in rows and full observations made. There appears to be some segregation for pigmentation in all the strains and this is being examined. It may be necessary to make further selection.

TABLE 3

Layout Randomized Block 5 replications.

Plots $13\frac{1}{2} \times 13\frac{1}{2}$ ft. planted at measured 6 in. spacing 2 plants per stand.

Area of plot harvested .003 acre.

<i>Variety</i>	<i>Mean Yield in lbs./acre</i>
Lead 44	3,215
Lead 35	3,155
Lead 20	2,940
Lead 42	2,890
Lead unselected	2,860
Lead 43	2,850
Lead 34	2,750
Lead 25	2,740
Lead 46	2,720
Coefficient of Variation	6.75

TABLE 4

Layout Randomized Block 5 replications
 Plots $13\frac{1}{2} \times 13\frac{1}{2}$ ft. planted at measured 6 in. spacing 1 plant per stand.
 Area of plot harvested .003 acre.

Variety	Mean Yield in lbs./acre
B.G.79 unselected	2,120
B.G.79/16	2,090
B.G.79/22	1,990
B.G.79/20	1,975
B.G.79/30	1,970
B.G.79/1	1,940
B.G.79/3	1,890
B.G.79/2	1,800
Coefficient of Variation	11.23

The 7 strains of B.G.79 were also planted in a yield trial at Maswari near the mouth of the Ribbi river. This is an area of marked salinity. Growth was poor and yields were low but there was a marked difference between varieties, and yields of the unselected stock and of strains 2 and 16 were highly significantly higher than those of the other strains. Table 5 gives full details. It is hoped to investigate this apparent difference in salt tolerance more fully.

TABLE 5

Layout Randomized Block 5 replications.
 Plots $14\frac{1}{2} \times 14\frac{1}{2}$ ft. planted at measured 6 in. spacing 2 plants per stand.
 Area of plot harvested 0.0036 acres.

Variety	Mean Yield in lbs./acre
B.G.79 unselected	835
B.G.79/2	810
B.G.79/16	720
B.G.79/30	361
B.G.79/22	345
B.G.79/20	275
B.G.79/3	210
B.G.79/1	160
Critical Difference (5%)	211 lbs./acre
" " (1%)	285 "
Coefficient of Variation	34.7

Older Selections

A number of strains of varieties are being kept for milling tests. It has not yet been possible to carry these out as the new experimental mill has not yet been received.

The position remains much the same as last year therefore, the strains remaining being as follows:—

Toma (local)	14 strains
India pa lil (local)	13 "
Sughandi (ex Burma)	8 "
Kalimodu (local)	7 "
Kurulutuduwi (ex Ceylon)	6 "

Pokkali (ex Ceylon)	5 strains
Kavunginpothala (ex Madras)	5 „
Indo-China (ex French Sudan)	4 „
Ngasein (ex Burma)	3 „

Of these, full observations were kept on the Sughandi and Kurulutuduwi selections. The latter in particular appear to be segregating and in view of some very promising rices of similar long duration among recent introduction it is proposed to discard them.

HYBRIDIZATION

The F3 generation of the series of crosses made in 1951 were again planted out as single plants. Mass selection of plants showing the desirable characters was carried out at harvest, the resulting seed being kept for 1955 sowing. These crosses are:—

D.C.39/15	×	Yenti 38
Ngasein 57	×	Tai Chu
Toma 112	×	Ngasein 57
India pa lil 46	×	Kav. 12

The seed of all but one of the crosses made last year failed to germinate. No explanation of the failure can be offered as even after several weeks in the soil, the seed looked good. The cross that did germinate was the one between non-pigmented Indo-China 24 and pigmented Indo-China 53. 43 plants were obtained, all hybrids, as was shown by the fact that all of them had pigment at the base of the stem and in the apiculus. They grew very vigorously and seemed to be more luxuriant than the present selections, but whether or not this was hybrid vigour cannot be assessed, it may have been a result of a more favourable situation. The yield from these plants was 5 lbs. 1 $\frac{3}{4}$ ozs.

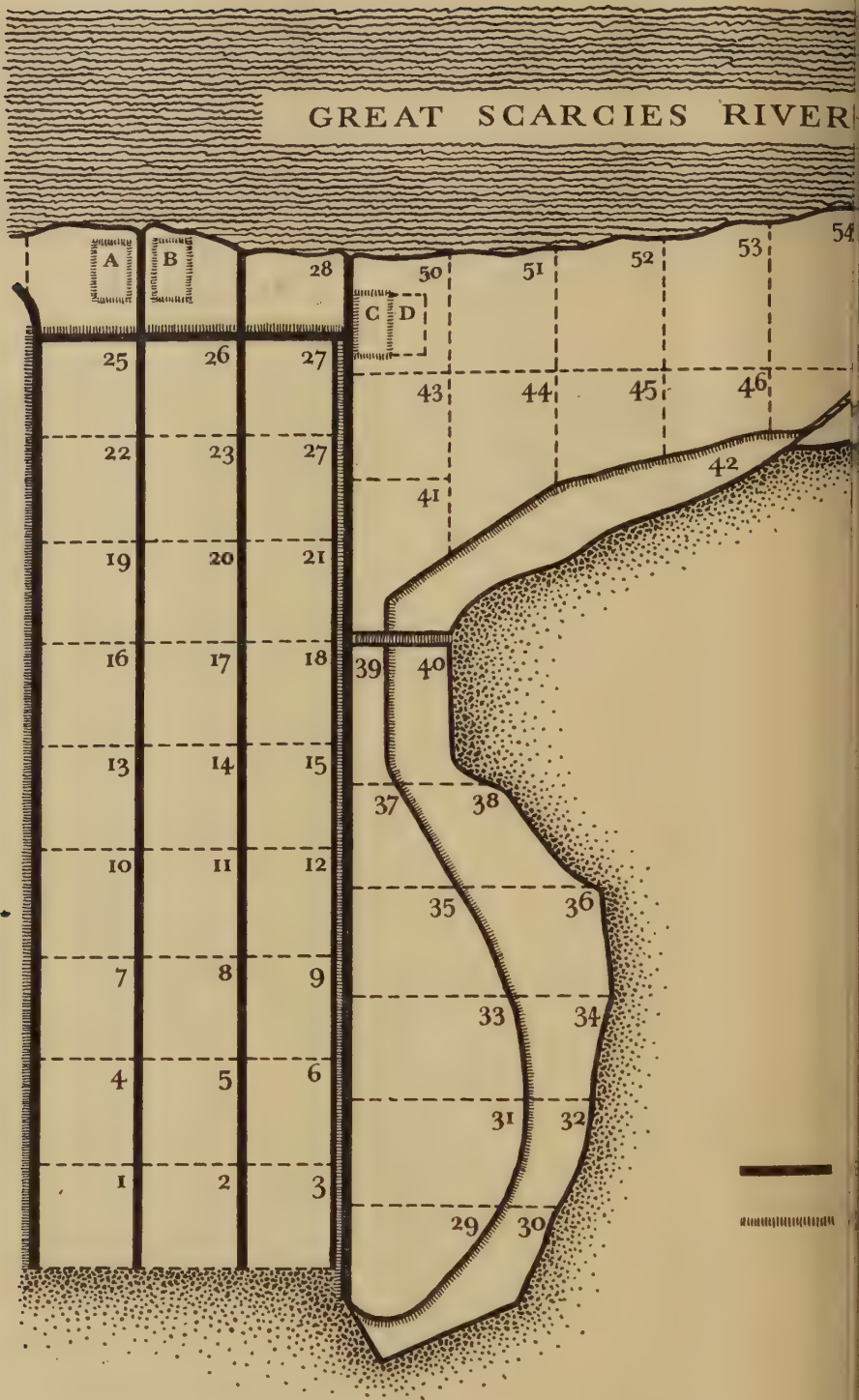
Very little hybridization was attempted this year, it being thought advisable to wait until pure strains of parent material are available and a definite object is in view with each cross. The technique is satisfactory; emasculation using the hot flask technique has never given any trouble, the pollination technique which was finally developed was to subject a detached panicle to the opening process and as soon as the first spikelets opened their anthers were removed on to a watch glass. It was found that such anthers were most mature and hence dehisced most readily at the next stage. To effect pollination an anther is picked up by one end and pressed or rubbed gently against the inner surface of the palea. If sufficiently mature it dehisces and pollination results. Experience has borne out the previous years assertion that the choice of time of working is of prime importance. The ideal time is as close as possible to the time the spikelets open naturally, but while an artificially opened spikelet can still be emasculated without any of the anthers dehiscing. At such a time the pollination process is most likely to be easily accomplished.

The crosses attempted were Lead × B.G.79 and Lead × D.99, 22 and 15 seeds being obtained respectively. The purpose of the crosses is to decide whether or not these combinations would serve as a basis for experiments on the amount of natural outbreeding that occurs here. The essentials for their suitability are first that there are no incompatibility barriers between them, and second that their hybrids should exhibit pigmentation at an early stage in its growth—i.e. be distinguishable from the self—Lead being unpigmented while B.G.79 and D.99 have anthocyanin pigmentation.

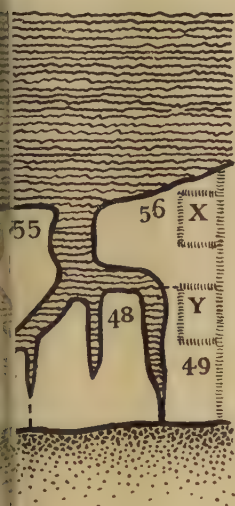
MAINTENANCE OF GENETIC PURITY

The process of bagging 3 typical plants of each of the 7 Genetic Stocks

ROKUPR FARM: I



NTING PLAN 1954



Block	Variety
1	India pa lil 46
2	Selections
3	Selections
4	Selections and Toma 112
5	Selections
6	Selections
7	D 99
8	Lead
9	Collection
10	B.G. 79 and Lead
11	B.G. 79
12	Collection
13	Kav. 12
14	India pa lil 46
15	Collection
16	Promising Varieties
17	Promising Varieties
18	Collection
19	Promising Varieties
20	Promising Varieties
21	Collection
22	B.G. 79 Fertilizer Trial
23	B.G. 79
24	Collection
25	Ngasein 57
26	Ngasein 57
27	Ngasein 57
28	Bolo 108
29	Hybrids
30	Kav. 12
31	Yield Trial and India pa lil 46
32	Kav. 12
33	Yield Trial and India pa lil 46
34	Kav. 12
35	Yield Trial and India pa lil 46
36	Kav. 12
37	D 99
38	Kav. 12
39	D 99
40	India pa lil 46
41	D 99
42	India pa lil 46
43	Lead
44	Promising Varieties
45	Ngasein 57
46	Ngasein 57 and Kav. 12
47	Ngasein 57 and India pa lil 46
48	Ngasein 57 and India pa lil 46
49	Ngasein 57 and India pa lil 46
50	Bolo 108
51	Bolo 108
52	Bolo 108
53	Ngasein 57
54	Ngasein 57
55	Ngasein 57 and India pa lil 46
56	Ngasein 57
A	Sughandi
B	Sughandi
C	Sughandi
D	Sughandi
X	Sughandi
Y	Sughandi

WINS

EDS

was successfully begun this season. Next season the lines from which the selected plants are bagged will be single panicle cultures. Muslin bags were used, they seem to create a more congenial atmosphere around the bagged plant than the thicker delva bag formerly employed, it is thought that a higher percentage of grain setting was the consequence.

DISEASES

Attacks of fungus this season, apart from *Piricularia* in the nurseries, were confined to *Ephelis pallida* being found on D.99 on blocks 37 (5 panicles), 39 (19 panicles) and 41 (11 panicles), and on India pa lil 46 on blocks 33 (7 panicles) and 46 (3 panicles). This fungus has occurred on D.99 in the last four years but it is the first time recorded on India pa lil 46.

The smut, *Neovossia horrida* was recorded on a single grain of a rice introduced from the Phillipines in 1952—Raminad. This is possibly the first record of this smut on *Oryza sativa* in Africa, though it was found in Sierra Leone in 1953 on the wild *Oryza barthii*. No further occurrence has been observed.

MISCELLANEOUS

Routine collections of algae have continued throughout the year, the samples being sent to Bangor for determination. Further collections of phanerogams and ferns have also been made for the station herbarium.

CHEMISTRY SECTION

From 3rd August to 9th September, 1954 the Chemist was absent from Rokupr to visit the 2nd. C.C.T.A. Soils Conference and the 5th International Congress of Soil Science at Leopoldville, Belgian Congo.

TRAINING OF ASSISTANT STAFF

Since May the Laboratory Assistant has been trained by the Laboratory Superintendent in basic laboratory techniques. He has had much practice in the determination of mechanical analysis of soils and some in titrations, and has been responsible for such routine work as renewal of desiccants. Some grounding in the theoretical aspect of chemistry has also been given. His progress has been satisfactory.

BASIC LABORATORY TECHNIQUES

Much time was necessarily taken by preparations of standard solutions and laboratory reagents in general and in the development of analytical techniques. Lack of electrical services and gas prevented progress with the last, with the exception of analysis for calcium and magnesium. A satisfactory method for these two elements making use of disodium ethylene diamine tetraacetic acid was developed but an attempt to use the reagent in the analysis of ferrous and ferric iron separately did not succeed.

ROUTINE INVESTIGATIONS

Soil samples were taken from the three experimental polders of Rokupr farm at monthly intervals and the pHs determined. It is already evident that there is a fluctuation of pH during a year, the range of which may be as great as 3 units. It is considered possible that this fluctuation may be accompanied by fluctuations in nutrient levels. Such fluctuation

would be of great importance should soil analysis be applied to fertilizer application and it is therefore planned to extend the scope of this investigation. pH readings, and in a few cases salinities, of sites from which algal samples are taken by the botanical section, have been determined.

SPECIAL INVESTIGATIONS

The investigations fall into three groups.

- (a) Investigation of the relationship, if any, between mangrove vegetation and the change of pH of soil on drying. This involved visits to mangrove swamp areas along almost all the coastline of Sierra Leone.
- (b) Investigation of the extent of rice growing without empoldering in the Samu Chiefdom Saline Swamplands. Periodic reports have been made on this work, the main conclusion of which was that little empoldering for the exclusion of salt water is necessary. The only area where such empoldering appears to be essential is around Mahela and Palmaro Creeks.
- (c) Survey of Mapotolon Polders with a view to determining the pH pattern and its relationship to original vegetation and rice cultivation.

(a) *Mangrove Vegetation as an Indication of the effect of drying on Soil reaction*

In recent years it seems to have become the practice in Sierra Leone to regard the presence of *Avicennia nitida* as an indication that areas may be empoldered without the development of adverse soil conditions. While there are yet no laboratory methods which have been correlated with field experiments and may be used to assess with certainty whether or not a soil may be dried without the development of ill effects, it seems probable that if low pHs are produced when soil is dried for a period of about 2 months in the laboratory, drying out under field conditions is likely to lead to soil conditions in which rice cannot grow. The pH figure to be taken as critical is uncertain, but 5.0 seems a reasonable value.

During the course of the past nine months the opportunity has been taken to collect soil samples from beneath different types of mangrove at widely scattered points in Sierra Leone, and it is instructive to compare the pH changes which have been found on drying. In the main the figures quoted are for soils under virgin mangrove; a few from cleared areas are included but only in cases where the original mangrove is known with certainty.

Vegetation	No. of samples	No. of samples pH of which fell to 5.0 or less on drying for 2 months or more	Percentage of samples pH of which fell to 5.0 or less on drying for 2 months or more
<i>Rhizophora racemosa</i>	19	7	37
<i>R. harrisonii</i>	10	4	40
<i>Avicennia nitida</i>	18	7	39
<i>Laguncularia racemosa</i>	2	1	50

The primary aim in collecting the samples was not the application of this test and it is regretted that no soil samples from under *Rhizophora mangle* are available.

In view of the comparatively small number of samples, it is perhaps fortuitous that the percentages of soils developing high acidities are

so similar. On the other hand, it appears that the mangrove vegetation carried by the land does not provide a satisfactory means of estimating whether or not the soil is likely to develop acidity on drying. In spite of the uncertainties involved in the test, it would seem advisable to assume that this is the case when areas which it is proposed to empolder are surveyed. Unfortunately no alternative method on which to base such a survey can yet be proposed, but attempts will be made to discover one as soon as possible.

The figures above should be compared with those of J. M. Dent, (Emp. J. Exp. Agr.: **15**, 210 (1947). 2 out of 3 samples taken from under *Rhizophora* and 3 out of 10 samples taken under *Avicennia* showed acidities greater than pH=5. The period of time which elapsed between taking the soil samples are not stated in the paper.

(c) *Mapotolon Survey*

Of the empoldering schemes in the Scarries area, Mapotolon is probably the most profitable to study. Unlike Bambaia and Bakepet, it is a case where empoldering is certainly necessary if rice is to be grown. The two polders are of different ages and both are still quite new. The original vegetation included all the important mangroves found in the seasonally saline swamps of Sierra Leone and there is known to be a considerable variation in soil conditions. Local farmers appear keen to grow rice in the polders.

Collection of Soil Samples

Samples were collected from 27th to 30th April. The April rainfall at Mapotolon may be relevant to later discussion. It totalled 7.37 in., 4.52 in. of which fell during the second half of the month. Sampling inside the polders was based upon 5 acre farming plots. Samples of surface soil (0-3 in.) were taken at about 8-10 places inside a unit. After mixing, about $\frac{1}{3}$ to $\frac{1}{2}$ of the composite sample was taken and stored in a 4 oz. glass bottle, with a screw cap, until analysis. It may not be possible to obtain representative samples from so large an area as 5 acres, especially if the factors investigated vary rapidly over small distances.

When sampling at sites, a rectangular hole about 3 x 4 ft. was dug down to the water table. The profile was described in the usual way, excepting that no attempt was made to allow the soil to dry out and "structure-up." Depths of sampling were determined with a measuring tape. It was impracticable to sample much below the water level in the pit. Samples from the polders and sampling sites are most conveniently discussed separately.

Examination of Polder Samples

The range of pH values found was from less than 3.6 to 7.2 units. The values were mapped and compared with the map of the original vegetation which was based on examination of aerial photographs. The association of acid areas with areas which previously carried high mangrove, probably *Rhizophora racemosa*, is very striking. In Polder "A," which has now been bunded for 2 dry seasons, all areas which previously carried *R. racemosa* are now acid and no other areas are. The correspondence is not so close in Polder "B," which has been bunded for only one dry season, where some areas which carried low mangrove are acid and some areas which carried high mangrove are not. There is some uncertainty in the superimposition of the polder and vegetation maps, but it is not thought to be great. There is in both polders a close association between acid areas and areas where the surface soil is fibrous (fibrous soils are generally associated with *Rhizophora*

spp.). It appears that acidity only develops in areas which were originally under mangrove but, as the greater part of Polder "B" was originally mangrove, there must be some doubt about that association on this evidence alone. The close association between acidity and an original vegetation of *Rhizophora racemosa* is in contrast to the results reported in an earlier section. The "low mangrove" of the vegetation map is a mixed stand consisting mainly of *Avicennia nitida*, *Rhizophora harrisonii* and small *R. racemosa*.

Salinity was estimated by the determination of the chloride ion content of samples.

The salinity values found were in the range 0 to 36,000 ppm. on a wet soil basis. They were mapped. One point which is immediately striking is the generally lower chloride content in Polder "A" than in "B," in spite of the similarity of the salinities external to the polders; if anything, that outside Polder "A" is the higher. One object of this study was to determine whether the effect observed in Polder "C" of Rokupr Farm, a higher chloride content inside the polder than outside, which presumably owes its origin to seepage under the bunds and concentration of the saline water inside, is present with these larger polders. In Polder "A" the drainage and bunding systems clearly lead to a salt content inside the polder which is lower than that outside at the end of the dry season. That this is not true of Polder "B" may be due to the fact that it was only completed in 1953. The non-uniformity of chloride content shows a concentration of salt in various parts of the polder, probably due to differences in micro-relief. This suggestion would account for the fact that high salt areas are not necessarily at the edge of the polders. It will be shown by consideration of the profile pit samples that the rainfall prior to the collection of samples is unlikely to affect these conclusions.

As regards the actual magnitude of the figures obtained, it is unlikely that they give any indication of salinity conditions at the beginning of the growing season. In view of the fact that crystalline salt is prepared from the surface soil as a subsidiary industry at Mapotolon, and rice is later grown on some of the areas used, the content of salt in the soil must fluctuate very markedly during the year.

Examination of Profile Pit Samples

Experimental procedures employed were identical with those used for polder samples.

The variation in soils over the polders is considerable. The non-fibrous soils examined however usually had a dark brown-grey surface layer, of less than 6 in. depth, underlain by a blue-grey layer, mottled with orange-yellow, and sometimes also purple stains. The mottling varied in density, in one case indurations gave rise to a layer with a distinctly gravelly texture. The indurations, and the stains in general, are associated with old root channels. With increasing depth indurations or stains become less common and the soil changes to darker blue in colour. The majority of the soils were sandy at depth. In nine of the ten cases the ground water was tested and found to be saline. The depth of the water table seemed to vary from about a foot to 4 feet. The fibrous soils showed no differentiation into horizons; characteristic yellowish stains were present.

pH always increased with depth. This confirms quite definitely that the high acidities found result from oxidation. Comparison of pH values inside and outside the polders shows that this oxidation follows empoldering. Only one of the 18 samples from outside the polders has a pH of less than 5 and that is from a native polder. The

much higher external pH values when an acid region borders the perimeter bund are very striking.

Salinity is not so regular. There is generally a slightly higher chloride content at the surface than immediately below, which indicates that wash down of salt had not become important at the time of sampling. Of the 10 sites, 3 showed a large increase at the surface and 2 a slight reduction. Deeper in the profile the chloride content invariably increases. Data from a site in Polder "B" are quite typical of general trends and are given below:—

Depth	Description	Depth	pH	Moisture % w.s.	Salinity ppm. wet basis
	<i>Sesuvium portulacastrum</i> with regenerating mangrove, very young <i>Rhizophora</i> sp.				
0-6"	Dark grey-brown, sufficient root to give rather fibrous feel.	0-2"	6.4	17.2	5,100
6-36"	Rapid change to light blue grey layer with some tongues of surface horizon and vertical bright orange streaks.	8-11"	6.5	24.8	5,300
		21-23"	6.8	26.1	4,700
36"+	By this depth the streaks have become much less distinct and the appearance changed to a fairly uniformly coloured light brown grey.	32-36"	7.9	26.6	7,300
46"	Saline ground water.	44-46"	7.9	30.6	8,700

Both fine and large roots are present throughout the exposure, hard, partly decayed mangrove roots were found at the bottom. The soil is rather sandy throughout but with sufficient clay to make it adhere.

Two samples of ground water were taken, one from outside Polder "B" and one from inside. The difference in Chloride contents, 0.654N (23,200 ppm.) for the first and 0.339N (12,000 ppm.) for the second, is quite striking. The first figure is rather greater than that for sea water, about 0.5N.

Conclusions

The following conclusions can be drawn at this stage:

- (i) Parts of the polders have a very low pH. The distribution of such areas is dependent upon the original vegetation. Low pHs are only found in areas which previously carried mangroves and usually the mangrove was high *Rhizophora racemosa*. Such acid soils are moreover almost always fibrous in texture.
- (ii) The salt content of the soils is lower inside Polder "A" than outside. Some parts of Polder "B" contain more, others less, salt, than outside but the distribution is not related to previous "saltpan" areas or to the previous vegetation. The general lack of correspondence between salt contents of adjacent places inside and outside the bunds indicates that the enclosed area is a distinct unit from the point of view of salinity. Presumably therefore the bunds and drains are performing one of the major purposes for which they were designed.

(iii) pH increases in passing vertically down a soil profile. The behaviour of salt content is not so regular but there was no evidence for the washing out of salt at the time of sampling.

(iv) In general the soil profiles show three horizons. A surface grey-brown one is underlain by a pale blue horizon mottled with orange and sometimes containing concretions, an horizon of fluctuating oxidizing-reducing conditions. Beneath this is a darker blue un-mottled horizon. In almost all the soils investigated the lowest horizon had a sandy texture.

INVESTIGATION OF THE GROWTH OF RICE

The Mapotolon polders were examined on 23rd September in order to determine whether the distribution of rice could be correlated with the pH pattern found in April.

No definite relationship between growth of rice and pH distribution could be inferred from the results. To some extent this may be due to so small a proportion of the total area of polders being under rice, (upper figures for cultivation were 20—25 per cent of the part of polder “A” examined and 20 per cent of polder “B”) for it was generally impossible to determine whether rice had been planted and had died, or whether it had not been planted at all. Moreover, local experience had already shown that some areas previously under *Rhizophora racemosa* cannot support the growth of rice, although the phenomenon is attributed not to acidity but to excessive flooding consequent upon the low elevation of the areas (*R. racemosa* occurs along the edges of creeks); and it is unlikely that such areas were planted.

P. ADAMES

Principal Agricultural Officer.

APPENDIX A METEOROLOGICAL RECORDS ROKUPR—1954

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Rainfall (20 year average)	0.00 (0.13)	0.07 (0.05)	0.89 (0.42)	6.32 (1.86)	8.11 (6.80)	13.42 (14.18)	34.83 (23.23)	39.78 (29.38)	12.87 (18.00)	8.49 (15.09)	9.48 (5.52)	0.74 (0.66)	135.05 (115.82)
Sunshine (15 year average)	263.4 (251.0)	224.7 (228.8)	242.7 (241.3)	191.2 (203.7)	190.7 (193.5)	142.9 (160.0)	83.5 (105.9)	41.4 (63.3)	133.3 (128.0)	201.0 (189.0)	190.2 (199.5)	234.9 (224.4)	2139.9 (2196.2)
Mean Maximum Temperature (15 year average)	91.0 (91.1)	91.9 (93.0)	91.7 (93.3)	92.0 (92.9)	89.8 (91.0)	85.7 (88.2)	82.0 (84.3)	80.5 (81.8)	85.5 (85.4)	86.8 (88.4)	88.0 (89.0)	88.9 (89.5)	87.8 (89.0)
Absolute Maximum Temperature (15 year record)	92 (102)	96 (101)	95 (102)	97 (103)	93 (101)	91 (99)	89 (98)	89 (91)	89 (99)	91 (96)	91 (96)	91 (97)	97 (103)
Mean Minimum Temperature (10 year average)	68.5 (68.1)	69.5 (69.5)	71.1 (71.9)	72.7 (73.5)	73.0 (73.7)	72.4 (72.9)	71.4 (72.4)	71.5 (72.5)	72.4 (72.5)	70.6 (71.9)	71.3 (72.0)	69.8 (69.2)	71.2 (71.7)
Absolute Minimum Temperature (10 year record)	63 (55)	65 (60)	68 (66)	70 (66)	71 (69)	69 (64)	69 (60)	69 (68)	69 (68)	68 (68)	68 (63)	66 (53)	63 (53)
Mean Relative Humidity a.m. (11 year average)	90.1 (87)	88.8 (87)	81.5 (82)	84.7 (79)	86.7 (83)	90.6 (89)	92.3 (93)	92.0 (95)	90.8 (93)	86.2 (91)	89.4 (91)	89.4 (88)	88.5 (88)
Maximum Relative Humidity a.m. (11 year record)	99 (100)	95 (100)	95 (100)	96 (100)	95 (100)	95 (100)	100 (100)	100 (100)	99 (100)	98 (100)	98 (100)	95 (100)	100 (100)
Mean Relative Humidity p.m. (11 year average)	48.8 (48)	51.0 (49)	54.4 (51)	60.3 (55)	68.0 (62)	76.7 (73)	83.6 (80)	83.0 (85)	76.3 (78)	71.9 (75)	70.1 (68)	60.8 (58)	67.1 (65)
Minimum Relative Humidity p.m. (11 year record)	24 (12)	32 (15)	45 (19)	38 (28)	54 (34)	62 (44)	61 (54)	61 (54)	51 (51)	59 (57)	58 (37)	41 (23)	24 (12)

Rainfall in inches. Sunshine in hours. Temperature in degrees Fahrenheit. Relative Humidity as percentages. Morning readings taken at 09-00 hours. Afternoon readings taken at 15-00 hours. Bracketed figures are averages and records.

APPENDIX B RICE SENT OVERSEAS—1954

Zanzibar

Lead	...	...	...	...	ex British Guiana
D 99	...	...	...	...	ex British Guiana
D 52/37	...	...	...	...	ex British Guiana
B.G. 79	...	...	...	...	ex British Guiana
Patnai	...	...	...	...	ex Pakistan
H.R. 1	...	...	...	...	ex Hyderabad
Kogbandi	...	...	...	...	Local upland
Joboi	...	...	...	...	Local upland

Trinidad

Yenti 38	...	...	...	...	Selected Rokupr
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Jamaica

Lead	...	...	...	...	ex British Guiana
Patnai	...	...	...	...	ex Pakistan
H.R. 35	...	...	...	...	ex Hyderabad
G.E.B. 24	...	...	...	...	ex Madras
Sughandi	...	...	...	...	ex Burma
HM C19	...	...	...	...	ex Burma
MLY B 404	...	...	...	...	ex Burma
Mayang Ebos 80	...	...	...	...	ex Malaya
Kahogo	...	...	...	...	ex Tanganyika
Toma 112	...	...	...	...	Selected Rokupr
India pa lil 46	...	...	...	...	Selected Rokupr
Pokkali 2	...	...	...	...	Selected Rokupr

India & Indonesia

Lead	...	...	...	...	ex British Guiana
D 99	...	...	...	...	ex British Guiana
B.G. 79	...	...	...	...	ex British Guiana
Sughandi	...	...	...	...	ex Burma
Kav. 12	...	...	...	...	Selected Rokupr
Toma 112	...	...	...	...	Selected Rokupr
Bolo 108	...	...	...	...	Selected Rokupr

Gambia

D.C. 39/15	...	...	...	...	Selected Rokupr
Kav. 12	...	...	...	...	Selected Rokupr

Nigeria

Baisbis	...	...	...	...	ex Pakistan
Gabura	...	...	...	...	ex Pakistan
Serendah	...	...	...	...	ex Malaya
Milek Kuning 3	...	...	...	...	ex Malaya
Mayang Sa Gumpal	...	...	...	...	ex Malaya
Morak Sepilai	...	...	...	...	ex Malaya
Serendah Kuning	...	...	...	...	ex Malaya
Ngasein 23, 39 & 57	...	...	...	...	Selected Rokupr
Kav. 12	...	...	...	...	Selected Rokupr
Kema	...	...	...	...	Local

APPENDIX C

FARM YIELDS—1954

(In lbs./acre)

Block	1935-43	1944	1948	1949	1950	1951	1952	1953	1954
1	900	690	910	970	3,250	1,760	—	1,060	1,050
7	1,280	1,710	1,710	2,220	480	2,200	2,370	1,580	1,740
8	1,400	2,100	2,280	2,280	—	—	2,020	—	1,480
10	1,550	3,190	540	2,030	1,740	970	2,650	1,170	2,200
11	1,330	2,280	290	1,440	1,220	580	2,370	1,420	2,200
13	1,810	2,740	1,290	2,630	2,680	960	2,540	460	2,146
14	1,570	2,170	10	1,640	2,670	1,000	2,480	1,760	1,640
22	1,650	770	720	1,760	1,560	2,310	2,940	—	3,220
23	2,080	1,050	1,130	2,400	2,190	2,310	2,660	—	3,030
25	1,710	1,560	1,780	2,950	2,460	2,620	3,170	270	2,690
26	2,300	680	860	1,860	2,840	1,720	3,480	280	2,800
27	2,840	1,020	840	2,050	2,360	2,280	3,080	480	3,160
28	2,040	2,640	2,100	1,940	1,710	1,660	1,520	860	2,220
30	—	—	—	—	—	610	1,600	840	650
31	—	—	2,710	810	1,680	1,830	1,170	—	1,510
32	—	—	600	160	930	600	500	1,930	530
34	—	—	1,320	1,290	800	780	1,970	1,170	700
35	—	—	1,210	1,040	1,070	1,360	1,320	—	1,770
36	—	—	1,500	1,590	790	910	1,460	440	550
37	—	—	1,840	960	1,440	1,100	1,150	1,150	1,560
38	—	—	—	—	—	780	1,190	470	760
39	—	—	680	530	1,260	660	1,010	860	960
40	—	—	—	—	—	130	660	310	460
41	—	—	1,450	1,320	1,750	1,350	1,720	1,210	1,400
42	—	—	—	—	—	980	1,370	810	1,320
43	—	—	1,310	1,500	2,580	2,210	2,440	1,090	2,280
45	—	—	1,310	750	1,530	1,140	1,670	1,000	1,540
46	—	—	—	—	—	610	1,380	800	1,990
47	—	—	—	—	—	1,100	910	360	770
48	—	—	—	—	—	1,130	1,270	380	450
49	—	—	—	—	—	880	910	370	860
50	—	—	2,750	2,200	2,970	2,530	520	1,370	2,290
51	—	—	1,810	1,280	1,980	1,360	1,280	1,860	2,400
52	—	—	1,380	990	870	1,160	2,430	1,160	2,180
53	—	—	1,680	950	1,320	1,190	1,590	1,550	1,640
54	—	—	1,440	740	1,210	1,130	1,820	650	1,220
55	—	—	—	—	—	1,080	1,650	590	870
56	—	—	—	—	—	880	690	670	540

1944—First year of empoldering Blocks 1—27.

1948—First year of regained tidal conditions except Blocks 10, 11, 13 and 14.

Blocks 1 and 2 had heavy fertiliser application in 1950.

Blocks 10, 11, 13, and 14 were made tidal in 1949, water controlled again in 1950 and made tidal in 1952. Block 50 was only partly planted in 1952 on an old drainage channel and did badly.

APPENDIX D
RICE INTRODUCED—1954

From E. Pakistan

Patuakali
Rajasail
Maliabhongor
Katyabagdar
Dudh Laki
Goda Laki

From Orissa

FR—13A

From Ceylon

S.R. 26
Uvar Vellai

From Malaya

Seri Raja
Radin Kelumbong
Serendah Sungei Dua
Radin Che Ali

From Zanzibar

Shingo la Mjane
Sokotera
Mngazija
Kichawachawa
Madevu
Mkarafuu
Kibata

From British Guiana

D 54/42
D 85/42

From Argentina

Victoria Tardio F.A. Sel. 2
Precoz 2 F.A.
Yamani
Victoria F.A.
Japonesito de 3 meses sel.
Japones Gigante
Precosur 1 F.A.
Chacarero F.A.

